UNIVERSITY OF FLORIDA
EXTENSION
Institute of Food and Agricultural Sciences

2000 Florida Citrus Pest Management Guide: Citrus Canker[1]

T.S. Schubert, J.H. Graham and L.W. Timmer[2]

Citrus canker, caused by the bacterium *Xanthomonas axonopodis* pv. *citri*, is a leaf, fruit and stem spotting disease that affects numerous species, cultivars, and hybrids of citrus and citrus relatives. Grapefruit and Mexican lime are highly susceptible to canker, Navel, Pineapple and Hamlin sweet oranges, lemons and limes are moderately susceptible, Valencia orange, tangerines and tangelos are susceptible, and mandarins are moderately resistant.

Young lesions are raised on both surfaces of the leaf, but particularly on the lower leaf surface. The pustules later become corky and crater-like with a raised margin, sunken center and are surrounded by a yellow halo. Fruit lesions vary in size because the rind is susceptible for a longer time, and more than one infection cycle can occur on the fruit. Stem lesions can support long-term survival of the bacterium.

Major outbreaks of citrus canker occur when new shoots are emerging or when fruit are in the early stages of development. Frequent rainfall in warm weather, especially during storms, contributes to disease development. Citrus canker is mostly a leaf-spotting and fruit rind-blemishing disease, but when conditions are highly favorable for infection, it causes defoliation, shoot die-back, and fruit drop. When feeding galleries of Asian leafminer on leaves, stems, and fruit become contaminated with the bacterium, the number and size of individual lesions greatly increases and results in tremendous inoculum production.

The bacterium reproduces in lesions on leaves, stems, and fruit. When there is free moisture on the lesions, the bacteria ooze out and can be dispersed to new growth and other plants. Wind-driven rain is the main dispersal agent, and wind speeds > 18 mph aid in the penetration of bacteria through the stomatal pores or wounds made by thorns, insects and blowing sand. Leaves, stems, and fruit become resistant to infection as they mature. Almost all infections occur on leaves and stems within the first 6 weeks after initiation of growth. The most critical period for fruit infection is during the first 90 days after petal fall. Infection after this time results in the formation of only small and inconspicuous pustules.

1. This document is part of the 2000 Florida Citrus Pest Management Guide, Florida Cooperative Exension Service, Institute of Food and Agricutlural Sciences, University of Florida. Date printed: September 1999. For a copy of this handbook, request information on its purchase at your county extension office. Please visit the EDIS Web site at **http://edis.ifas.ufl.edu**.

2. T.S. Schubert, FDACS, Division of Plant Industry, Gainesville; J.H. Graham, professor, soil scientist, Citrus REC, Lake Alfred, Florida; L.W. Timmer, professor, pathologist, Citrus REC, Lake Alfred, Florida; Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, 32611.

Most spread of canker bacteria by wind and rain is for short distances, i.e., within trees or to neighboring trees. Cankers develop more severely on the side of the tree exposed to wind-driven rain. Spread over longer distances, up to miles, can occur during severe tropical storms, hurricanes, and tornadoes. Long-distance spread more commonly occurs with the movement of diseased plant material, such as budwood, rootstock seedlings, or budded trees, or less commonly on fruit and leaves. Workers can carry bacteria from one location to another on hands, clothes, and equipment. Grove equipment spreads the bacteria within and among plantings, especially when trees are wet.

In countries where citrus canker is well-established, resistant types of citrus, such as Valencia oranges and mandarins, are usually grown. In regions where canker is endemic, windbreaks are planted to reduce wind speeds and canker spread. Frequent applications of copper-containing bactericide sprays have been shown to be effective for protection against fruit lesions. Because young fruit is particularly susceptible to canker, a protective coating of coppers should be maintained on the fruit surface in the first 90 days after petal fall. Leafminer control is particularly important on young trees and in those cultivars that have frequent flushes of growth.

Florida now has citrus canker in three distinct geographic areas of the state: in South Florida (Dade & Broward Counties), in West Central Florida (Manatee Co.) and more recently in the Southwest Florida vicinity of Immokalee (Collier Co.) and Clewiston (Hendry Co.). DNA testing of the bacteria from the Manatee and Miami areas identify them as different introductions of the pathogen and confirms that the outbreaks in Immokalee/Clewiston areas are related to the bacterium in Miami. Thus, canker has been spread from established infestations to new areas by operations and meteorological events. Outbreaks provide evidence that people-assisted movement of the pathogen may occur over long distances since grove services and harvesting crews are often contracted within and between companies located throughout the industry.
Decontamination/disinfection procedures are crucial to reduce the risk of further dissemination of the pathogen and increase the probability of eradication of the disease in Florida.

Citrus Canker Eradication Program (CCEP) Decontamination/Disinfection and Disease Control Guidelines

The following ranking recognizes three priorities for regulations:

Level 1 - Mandatory (see CCEP compliance Agreements)

Level 2 - Essential (from a biological standpoint)

Level 3 - Recommended

The circumstances for determining priorities for sanitation in regard to citrus canker are:

Circumstances:

A) The establishment is known to be canker-free by frequent negative inspections.

B) Canker status of the establishment is unknown at the present time (no regular systematic surveys for canker have been done yet).

C) The establishment is known to have had citrus canker in the last two years, or is within one mile of the establishment, or has had direct contact with infected establishments within the last year. In most cases, these establishments will be in the quarantine zone and under a Compliance Agreement, so disinfection guidelines will have the authority of a rule (i.e., mandatory).

Citrus Canker Decontamination Products

I. Hands and Clothing:

1. GX 1027® Antimicrobial Soap: Galloway Chemical Division, Clearwater, FL.

Diluted 1:54 with water, 1 tbs. per use. Use normal hand washing for 20 to 30 seconds, paying special attention to fingernails and between fingers, followed by water rinse. If

arms are also washed, more soap and water should be used. Avoid contact with eyes. Gallex is also approved for use on clothing being worn, with no rinse required.

2. Hibiclens®: Stuart Pharmaceuticals

One tsp. on wet hands per use. Use normal hand washing action for 20 to 30 seconds, paying special attention to fingernails and between fingers, followed by water rinse. If arms are also washed, more soap and water should be used. Avoid contact with eyes.

3. Hibistat®: Stuart Pharmaceuticals

Five ml. per use. Rub onto hands until dry (about 15 seconds).

4. Sani Clean Hand Soap®: H. Wilson Manufacturing Co.

Five ml. soap and 15 ml. of water per use.

II. Vehicles, Equipment, and Small Tools

A. Dual quaternary ammonium

1. Gallex 900® Galloway Chemical Division

(GX 900®) Clearwater, FL

EPA No. 1839-81-22061

Fax: (727) 536-1804

B. Multiquaternary ammonium

1. Process NPD® Calgon Vestal Laboratories

EPA No. 1043-90 St. Louis, MO

2. Citra-Solv® Flo-Tec, Inc.

EPA No. 10324-72-72160 Largo, FL

Phone: (727) 531-8796

C. Hot Water and Detergent

Wash thoroughly with a hot water and detergent solution, under high pressure, at a minimum of 160°F. Wet all surfaces to the point of runoff.

III. Packinghouse

A. Sodium-o-phenylphenate (SOPP)

Wash Solutions:

1. SOPP concentrations of 1.86% to 2% required.

2. SOPP formulations may be either soap or non-soap.

Wash Procedures:

1. The SOPP can be applied by drench, spray, or foam methods. The use of foam may require scrub brushes to assure total wetting of fruit surface.

2. All methods of treatment require the following exposure time after fruit becomes totally wet as described in chlorine treatment procedures.

a. SOPP/soap solutions - 45 seconds.

b. SOPP/non-soap solutions - 1 minute.

3. To prevent fruit damage, the solution pH would be maintained with a 11.5-12.2 range.

4. Fruit should be thoroughly rinsed. It is understood that residues of SOPP of less than 10 ppm will be left only in cracks and crevices of fruit.

B. Sodium Hypochlorite

Wash Solutions:

1) Water should be maintained within a range of 6 to 7.5 pH.

2) Available or free chlorine concentration should be mixed to 200 ppm (mg/L) and maintained within a range of 150 ppm to 250 ppm.

3) It is permissible to add 0.05% (v/v) nonionic surfactant to Sodium Hypochlorite wash solutions.

4) Sodium Hypochlorite levels above 500 ppm may cause fruit damage.

5) Change the wash water/Sodium Hypochlorite solution daily or more frequently, if necessary. Dirty water reduces free/available.

Wash Procedures:

1) Fruit can be washed in a tank that allows the fruit to remain in the wash solution for a period of two (2) minutes. Movement of the fruit through the tank must be controlled to assure that all fruit receives the full two-minute treatment.

2) A combination of spray nozzles and powered roller-type brushes arranged to allow for thorough wetting with the wash solution and scrubbing with the roller brushes is acceptable, provided the fruit remains thoroughly wet with the water Sodium Hypochlorite solution for two minutes.

General Recommendations

1. Avoid copper sprays near infested areas. Copper only suppresses infection rather than eradicating the disease, thereby making canker detection more difficult for CCEP inspectors. **(Disregard for circumstance A, recommended for circumstances B and C.)**

2. Minimize pruning activities to eliminate wound infection courts and to discourage large flushes of canker-susceptible tissues in areas of high inoculum pressure. **(Disregard for circumstance A, essential for circumstances B and C.)**

3. Do not collect samples of citrus for canker diagnosis. Note the location of the suspect plants, map the location, and immediately notify CCEP (Toll free number 800-850-3781). **(Essential for all circumstances.)**

Table 1. Practices for growers and caretakers.

	Canker Free (outside quarantine zone) **A**	Don't Know (outside quarantine zone) **B**	Canker Exposed or Infested (in quarantine zone, under compliance agreement) **C**
Equipment sanitation (coming out of grove)	Essential (sweep at source)	Essential	Mandatory (pressure clean and disinfect at source)
Clothing and hand/ shoes disinfection	Essential	Essential	Mandatory
Clean clothes and gloves every day	Optional	Recommended	Essential
Keep vehicles out as much as possible	Essential	Essential	Essential
Limit movement of people & equipment between blocks	Recommended	Recommended	Essential
Contract help should follow disinfection guidelines	Essential for entering, Recommended for exiting	Essential for both entering and exiting	Essential for both entering and exiting
Avoid working in wet conditions	Optional	Recommended	Essential
Collect samples for canker diagnosis	NO! Call CCEP.	NO! Call CCEP.	NO! Call CCEP.
Be certain to use disinfectants labeled for skin and clothing where appropriate. Do not use disinfectants labeled for equipment on skin or clothing. (See Citrus Canker Decontamination Products.)			

Table 2. Summary for harvesting operations.

	Canker Free (outside quaratine zone) **A**	Don't Know (outside quaratine zone) **B**	Canker Infected or Exposed (in quarantine zone, under compliance agreement) **C**
Disinfect all equipment (picking bags, ladders, bins, etc.) on entry and exit	Recommended	Essential	Mandatory on exit
Use non-porous picking equipment (plastic, smooth fiberglass, or aluminum tubs, ladders, etc.)	Optional	Recommended	Recommended
Harvest only when tree canopy is dry	Recommended	Recommended	Essential
Tarp all conveyances	Optional	Optional	Mandatory
Disinfect people and equipment (picking bags, ladders, bins, etc.) between blocks	Recommended	Recommended	Essential
Be certain to use disinfectants labeled for skin and clothing where appropriate. Do not use disinfectants labeled for equipment on skin or clothing. (See Citrus Canker Decontamination Products.)			

Table 3. Practices for nurseries.

	Canker Free (outside quarantine zone)	Don't Know (outside quarantine zone)	Canker Exposed (in quarantine zone)	Canker Infested (in quarantine zone)
Equipment sanitation	Essential	Essential	See note below	See note below
Clothing and hands/ shoes disinfeciton	Essential	Essential	See note below	See note below
Clean clothes/gloves every day	Optional	Recommended	See note below	See note below
Keep vehicles out as much as possible	Essential	Essential	See note below	See note below
Limit movement of people and equipment between blocks	Recommended	Recommended	See note below	See note below
Contract help should follow disinfection guidelines	Essential for entering, Recommended for exiting	Essential for both entering and exiting	See note below	See note below
Avoid working in wet conditions	Optional	Recommended	See note below	See note below
Collect samples for canker diagnosis	NO! Call CCEP.	NO! Call CCEP.	NO! Call CCEP.	NO! Call CCEP.
If citrus canker is found in a nursery, that nursery will undergo risk assessment, all infected and exposed trees will be destroyed, and the duration of the quarantine on any remaining inventory will be prescribed. Be certain to use disinfectants labeled for skin and clothing where appropriate. Do not use disinfectants for equipment on skin or clothing. (See Citrus Canker Decontamination Products.)				

Table 4. Practices for packinghouses and processing plants.

	Canker Free (outside quarantine zone) **A**	Don't Know (outside quarantine zone) **B**	Fruit from Canker Infested or Exposed Areas (in quarantine zone, under compliance agreement) **C**
Tarp all conveyances	Optional	Optional	Mandatory
Clean out and safely dispose of all debris from bin boxes and trailers	Recommended	Essential	Mandatory
Avoid dumping cull fruit and trash indiscriminately	Essential	Essential	Mandatory at approved disposal site
Disinfect bin boxes, tarps and trailers after clean out	Optional	Essential	Mandatory
Disinfection of fruit in packinghouse line	Optional	Optional	Mandatory